MADROÑO

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DISTRIBUTIONAL NOTES ON PLANTS OF THE WARM SPRINGS AREA, OREGON

Robert Ornduff and David H. French

In an earlier paper (Ornduff and French, 1958) we reported a number of distributional novelties discovered during the course of identification of nearly 2000 vascular plant specimens from the Warm Springs Indian Reservation in Oregon. This collection of plants was made in connection with ethnobotanical studies of the Chinookan (French, 1956), Sahaptin, and Paiute Indians at Warm Springs. The reservation consists of approximately 564,000 acres located in the southwest portion of Wasco County and the northwestern portion of Jefferson County in north-central Oregon. The summit of the Cascade range forms the western limit of the reservation, the Metolius River most of the southern boundary, and the Deschutes River in the central Oregon plateau the eastern boundary. The northern reservation boundary has been the subject of recent litigation and is technically farther north than indicated on most maps and marked on Highway 26. Our references in this paper are to the latter point on the highway, which we understand is located about 6.5 miles south of the junction of Highway 26 with Highway 52 (in Township 6 South, Range 10 East, Section 11, Willamette Base Line and Meridian).

Few plants from higher altitudes are represented inasmuch as most of our collecting was confined to areas visited by Indians—the yellow pine forests, wooded valley bottoms, and the treeless sagebrush and bunchgrass region. About 600 species are known to occur on the reservation, of which at least 56 are introduced. Herein we record additional novelties of distribution beyond those recorded in our first paper. Previously accepted distributional ranges are taken from such sources as Abrams (1940–51), Peck (1941), and Hitchcock, Cronquist, Ownbey, and Thompson (1955–59). In some of these works the ranges of the species are often broadly phrased and risk being over-generous. We have decided to eliminate from our list most, but not all, of those species covered by broad or ambiguous statements. It should be noted that our own discussions do not necessarily cover the total ranges of the species; unless otherwise stated, the statement of range following each species refers only to its distribution within Oregon.

We have examined specimens deposited in the herbaria at the University of Oregon (ORE), Oregon State College (OSC), University of California, Berkeley (UC), Willamette University (WILLU), and the University of Washington (WTU). We extend our thanks to the staffs of these herbaria for their many courtesies during our visits.

Our study of herbarium specimens confirmed our impression that the Warm Springs Reservation has seldom been visited by collectors. In some instances, however, we found in the above herbaria specimens from the

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Warm Springs area which alter the ranges of the species as they are now known through publication. The most significant of these collections are noted in our list.

Most of our specimens were identified by the first author, but the following specialists have also assisted: the late Carleton Ball (*Salix*), Francia Chisaki (*Boraginaceae*), Lincoln Constance (*Umbelliferae*), LeRoy Detling (*Cardamine*), Marion Ownbey (*Allium*), and the late Albert N. Stewart (*Panicum*). Arthur Cronquist and C. Leo Hitchcock have provided determinations in a large number of families. We are indebted to these botanists for their assistance.

In the following list the second author's collection numbers are used and, for the most part, the specimens exist as unicates in his herbarium at Reed College. Where noted, duplicates are at the New York Botanical Garden (NY) and the Herbarium of the University of California, Berkeley (UC). Because most of the collections were not made in duplicate and are thus not incorporated in larger herbaria, we feel justified in presenting these reports of new distributional data.

Native Species

Panicum pacificum Hitchc. & Chase. This grass is rarely collected in Oregon east of the Cascades. Our specimen, No. *908,* is from beside the Warm Springs River near the Agency-Simnasho road, Wasco County, and differs little from the coastal *P. occidentalis* Scribn., which may not be distinct. Other relevant collections: *Peck 15781* (WILLU) from Maupin, Wasco County, and *Peck 17490* (WILLU) from Imnaha, Wallowa County.

Carex eurycarpa Holm. Although frequently collected on the eastern slopes of the Cascades in Deschutes and Klamath counties, this sedge is rare to the northward in central Oregon. It has been collected from the east side of Mount Hood, Hood River County, *Henderson 959* (ORE); from the Suttle Lake area, Jefferson County, *Hitchcock* & *Martin 4883*; and our specimen, No. *1494* (NY) is from the east bank of the Deschutes River, near the Highway 26 bridge, Jefferson County.

Allium macrum S. Wats. Published records limit this onion to the Blue Mountain region of Oregon and Washington, but the species appears to be well-distributed in our area. We collected it on Miller Flat, Jefferson County, No. *597,* and on Sidwalter Flat, Wasco County, No. *1763*—both near Highway 26. Other Wasco County collections: near Kent, *Baker 804* (OSC, WTU); near Shaniko, *Cronquist 6935* (OSC, WTU), *Gale 99* (WTU); eight miles south of Maupin, *Peck 26247* (WILLU).

Allium nevii S. Wats. According to Marion Ownbey (in litt.) this species is infrequently collected in Oregon. It grows north of the reservation in Wasco County (cf. *Peck 26216* (WILLU) and other collectors); we found it on Sidwalter Flat, Wasco County, No. *1811* (duplicate at Washington State University, Pullman).

ALLIUM TOLMIEI Baker. Recorded east and southeast of the reservation, this onion appears to be well-distributed in our region. Our collection is from one mile up Tenino Creek valley from the Agency, Jefferson County, Nos. *478A, 478B*; also collected in this county by *Steward 6379* (OSC, WTU), Madras.

SALIX DRUMMONDIANA Barratt var. SUBCOERULEA (Piper) Ball. In Oregon, this species is rarely collected. Peck (1941) lists it only from the Wallowa Mountains, but our specimens are from thickets above Shitike Creek, near the Agency, Jefferson County, Nos. *40, 1291A, 1291B*; also collected in Deschutes County, *Whited* in 1907 (OSC) and Grant County, *Henderson 5165* (ORE).

ATRIPLEX CONFERTIFOLIA (Torr.) S. Wats. A member of the Great Basin flora which is sparingly represented on the reservation, this species is known from a considerable distance east of Warm Springs in Wheeler County. It appears to reach its northwestern limit on the reservation, where it grows with *Sarcobatus vermiculatus* (Hook.) Torr. on an alkaline flat in Wolfe Hollow, No. *1287*.

ACER CIRCINATUM Pursh. Though found mainly to the west of the Cascades, this maple is commoner on the eastern slopes than previously suspected. It is frequent near Beaver Creek (No. *353* came from the north boundary, Wasco County) and occurs along water courses traversing the more arid parts of the reservation. No. *205* was collected less than two miles west of the Agency, near Shitike Creek, Jefferson County. Other collections noted in herbaria are from scattered localities in Jefferson and Wasco counties. Warm Springs Indians say that they formerly obtained the tough wood locally and used it for fishing net hoops.

ANGELICA CANBYI Coult. & Rose. This species has not been reported from the Warm Springs region, where we have collected it south of Simnasho, Nos. *71* and *1966* (UC); Indian Head Canyon, No. *1273*; near Beaver Creek bridge on the Simnasho-Hehe Butte road, Nos. *1279, 1423, 1917, 1954* (UC); and near Nena Creek, No. *1553*—all in southern Wasco County. Other relevant specimens: *Thompson 4951* (WTU), Tygh Hill, Wasco County; and *Peck 18646,* near summit, Ochoco Forest, Crook County.

LOMATIUM COUS (S. Wats.) Coult. & Rose. Apparently not previously collected as far west as Warm Springs, where it is locally abundant. *Peck 26166* (WILLU), from eight miles south of Maupin, Wasco County, is near the reservation. Our Wasco County specimens: Nos. *473, 528,* south side of Warm Springs River valley, near Agency-Simnasho road; Nos. *1219, 1869* (UC), Sidwalter Flat, near Highway 26. Jefferson County: No. *649,* Miller Flat, north of Highway 26. Like other Indians of the Columbia Plateau, the Warm Springs Indians dig the starchy tubers for food.

LOMATIUM LEPTOCARPUM (Torr. & Gray) Coult. & Rose. Published records locate the western limit of this umbellifer in the Blue Mountains. However, *Cronquist 7425* (UC) came from Big Summit Prairie, Wheeler

County, and Peck has collected the species in various parts of Wasco County. Our Nos. *526* and *1896* (UC) came from west of Simnasho, and Nos. *584A, 584B, 584C,* and *1755* were collected about a mile northwest of Hehe Butte, all in Wasco County.

Lomatium nevadense (S. Wats.) Coult. & Rose var. nevadense. Warm Springs represents the northwestern limit for this Great Basin species, which was collected southeast of the Agency area longhouse, Jefferson County, Nos. *516A, 516B, 516C,* and *1900* (UC).

Pteryxia terebinthina (Hook.) Coult. & Rose var. terebinthina. Widely distributed in eastern Oregon, but not previously collected within many miles of Warm Springs. Both Nos. *1274* and *1897* (UC) came from Indian Head Canyon, near the Agency-Simnasho road, Wasco County; No. *1582* was collected from a rocky point north of the junction of the Whitewater and Metolius rivers, Jefferson County.

Campanula scouleri Hook. Although frequent in the woods of western Oregon, this species is rarely reported east of the Cascades. There are a few northern Oregon collections from the region east of Santiam Pass and from the eastern slopes of Mount Hood. Our specimens were found near Highway 26 at the northern reservation boundary, Wasco County, No. *1342*. Thus this species might be considered a regular inhabitant of the eastern slopes of the Cascades, at least in the northern portion of the state.

Senecio macounii Greene (=*S. fastigiatus* Nutt.) While this typically western Oregon species is very closely related to the eastern Oregon *Senecio canus* Hook., most specimens are clearly referable to one or the other species, and intermediates are lacking. A number of specimens from eastern Oregon have been referred by various collectors to *S. macounii,* although they more properly belong in *S. canus*. We have, however, found "good" *S. macounii* in the open pine woods at the Hehe celebration ground, Wasco County, Nos. *1463* and *1464* (both NY).

Stylocline filaginea Gray. Generally attributed to extreme eastern and southeastern Oregon, this species has recently been collected in Jefferson County 20 miles northeast of Madras, *Peck 26156* (WILLU) and from a single colony in the Agency area at Warm Springs, our No. *1690* (NY).

Tetradymia glabrata Gray. Another species reaching its northwestern range limit on the reservation. In Oregon, it is most frequently collected in the southeastern counties, but recently it has been found near Mitchell, Wheeler County, *Cronquist 7259* (OSC). Our plant, No. *1250* (NY), was growing southeast of Hehe Butte, Wasco County, about 75 miles northwest of Mitchell.

Introduced Species

Rubus laciniatus Willd. Sparingly established in Shitike Creek valley west of the Agency, Jefferson County (No. *980*). Only one other Oregon

specimen seen from east of the Cascade Mountains, *Small 30* (ORE), from Link River, Klamath County.

Anthriscus scandicina (Weber) Mansfield. This European species is well established in western Oregon, but only a single collection from east of the mountains was located in the herbaria: *Hitchcock 20441* (WTU), near the mouth of the John Day River, Sherman County. Our Nos. *827* and *942* came from a settled area west of the Agency.

Myosotis micrantha Pall. ex Lehm. In our earlier paper (Ornduff and French, 1958, p. 220) we mistakenly referred our No. *898 to M. discolor* Pers. This has proved to be another Old World species, *M. micrantha,* as has our (previously uncited) No. *1808* from Sidwalter Flat, Wasco County.

Discussion

In general, the new stations reported for the various species in the above list and in our previous paper are rather well-distributed over the reservation. There are few areas in which the "extra-limital" species are aggregated, as might be expected in view of both the geological and vegetational continuity of the reservation with much of the rest of central Oregon. An exception to this rule, however, is a large aggregation on or near the reservation of species characteristic of the more mesic western portions of the state, which are seldom collected east of the Cascade range. As might be expected, these species are typically inhabitants of moist ground along streams or rivers, or less frequently they are woodland plants. These species are: *Holcus lanatus* L., an introduction found in Wasco County by us and in Deschutes County by others; *Carex aperta* Boott., found by us in Wasco County, and known also from Union County; *Eleocharis obtusa* (Willd.) Schultes, known from Hood River, Umatilla, and Union counties, and here reported from Jefferson County; *Cardamine oligosperma* Nutt., found outside the reservation in Wasco and Sherman County, as well as by us inside the reservation in Wasco County; *Perideridia oregana* (S. Wats.) Mathias, found by us in two localities on the reservation in Wasco County, and known also from various Klamath County collections; *Trichostema oblongum* Benth., infrequent in the counties south of the reservation and collected by us on the reservation in Wasco County; *Artemisia douglasiana* Bess., growing along the Deschutes River in Jefferson County; and *Gnaphalium chilense* Spreng., sporadic in Deschutes and Umatilla counties and found by us in Jefferson County as well.

In addition to these characteristically western species which are seldom collected east of the Cascades, we have noted additional species which have apparently never been reported from east of these mountains. These are: *Juncus effusus* L. var. *pacificus* Fern. & Weig., locally abundant along Shitike Creek, west of the Agency, Jefferson County, Nos. *215, 940,* and *1509* (NY) as well as along Beaver Creek near the north reservation boundary, Wasco County, No. *1644*; *Achlys triphylla* (Smith)

DC., found well down on the eastern slopes of the Cascades at the north reservation boundary near Highway 26, No. *363,* and near the upper Warm Springs River, No. *866,* both Wasco County; *Ribes sanguineum* Pursh, various collections noted from Jefferson County sites, and also found in a number of localities along upper Beaver Creek where it parallels Highway 26, e.g., our Nos. *355, 627A, 627B*; *Angelica genuflexa* Nutt., found in scattered moist areas southeast of Mount Hood in Wasco County, as near Highway 26 one mile north of the north reservation boundary, No. *1846* (UC), and also collected by other workers east of the Cascade summit in Klamath County; *Gentiana sceptrum* Griseb., collected in a damp meadow near Highway 26 several miles southeast of its junction with Highway 52, Wasco County, No. *1389*; and *Veronica serpyllifolia* L. var. *serpyllifolia* from along Beaver Creek about 0.5 miles northwest of the Highway 26 intersection with the north reservation boundary, Wasco County, No. *1803.*

Most of the species discussed in the present and previous papers fall into two phytogeographical groups: (1) those which occur at Warm Springs in populations disjunct from the reported range of the species, and (2) those which appear to be beyond the margins of their previously reported ranges. In the first group are species such as *Convolvulus polymorphus, Phacelia thermalis,* and *Stylocline filaginea.* Intensive collecting in the areas adjacent to the reservation will likely show that many of these apparently disjunct stations are in fact connected with the main range of the species by geographically intermediate populations. In the second group are species such as *Pinus lambertiana, Allium macrum, Achlys triphylla, Angelica genuflexa,* and *Tetradymia glabrata,* many of which appear to be at their northern, southern, eastern, or western limits. The majority of the species in this latter group are those typical of the more mesic western portions of the state which have evidently migrated into suitable sites in our region either through the Columbia gorge and thence southward along the eastern slopes of the Cascades, or via the low mountain passes in the Cascades. Undoubtedly most of the weedy species reported are relatively recent introductions which may or may not become permanent members of the naturalized flora of the reservation. It is likely that a few native species, such as *Phacelia thermalis,* have been recently introduced and will not become established. However, the majority of the species we have discussed are well-established and occur in large colonies and/or in a number of widely separated vigorous populations. A notable exception is *Pinus lambertiana,* represented on the reservation by a few isolated senescent individuals which are not reproducing.

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G. THOMAS ROBBINS (1916–1960)

Early on the morning of February 11th, 1960, a few days after his forty-fourth birthday, G. Thomas Robbins, Herbarium Botanist in the Jepson Herbarium of the University of California Botany Department, died quietly in his sleep. The resultant sense of shock and loss among his botanical colleagues, especially those in Berkeley, was both deep and lasting.

Tom Robbins was born in San Francisco on February 6, 1916. While

he was still a boy, his family moved to Windsor in Sonoma County, California, and in the local schools and those in Santa Rosa, Tom received his elementary and high school education. His early interest in matters botanical was stimulated by the guiding hand of Mr. Milo S. Baker, who was his Professor of Botany during the two years of Tom's attendance at Santa Rosa Junior College. Later he attended the University of California at Berkeley, working meanwhile as a valuable student assistant in the University Herbarium, and graduating there in Botany in 1938 with a Bachelor of Arts degree. Later, he spent a profitable year at the University of Colorado during which he wrote an excellent monograph of the North American species of *Androsace,* which was later published in the American Midland Naturalist (Vol. 32, pp. 137–163, 1944). This work earned him the Master of Arts degree in 1941.

In 1946, Tom was appointed Associate Professor of Biology at the East Central State College at Ada, Oklahoma. Tom enjoyed his teaching activities greatly, but increasing deafness, which had been plaguing him for several years, became so acute as to force his retirement from a teaching career at the end of the school year in 1949.

Subsequently, for nearly three years, Tom was engaged as one of several botanical assistants aiding Dr. Herbert Mason, Director of the Herbarium of the University of California, in the preparation of "A Flora of the Marshes of California." Tom carried on some of the field work in connection with this project, contributed the final draft of the manuscripts of the Gramineae and Cyperaceae as well as of some genera in which he had a special interest, and aided in the solution of many taxonomic, bibliographic, and nomenclatural problems. Early in 1952, Tom joined the staff of the Jepson Herbarium as Herbarium Botanist, a position which he filled most capably, contributing manuscript on selected genera treated in the still unpublished portions of Jepson's "A Flora of California," which position he held at the time of his lamentably untimely death.

For some years, Tom gave unstintingly of his time and effort to fulfill the often thankless chores associated with his activities as Corresponding Secretary of the California Botanical Society.

As in the case of so many of his other pursuits, Tom's passion for excellence eventually resulted in his becoming a very fine photographer of close-up studies of native flowers, as the Kodachrome collection which he built up for the Jepson Herbarium well attests. Thus, as in his botanical endeavors, his life was enriched by a happy merging of vocational and avocational pursuits. Purely on the avocational level, Tom's interest in and understanding of music brought meaningful enjoyment, often shared with his closest friends, to his leisure hours.

Tom Robbins' outstanding characteristics were his gentleness, charity in judgment, an unusual ability to keep his own counsel, a passion for accuracy, and a tendency to reserve his judgment, either botanical or otherwise, until all pertinent data had been fully assessed and "digested."

To quote from a letter from Joseph Ewan, who was his professor while he attended the University of Colorado, "his meticulous care, almost fanatical, in the handling of records, and extreme interest in assembling all the pertinent literature on a topic before committing himself by way of a botanical judgment" were among his most valuable assets. These characteristics are amply exemplified in his last published work, "Notes on the Genus *Nemacladus*" (Aliso, Vol. 4, pp. 139–147, 1958), in which two new species and new interpretations of already published taxa were published.

Tom's name is commemorated in *Phacelia strictiflora* Gray var. *Robbinsii* Constance (Contr. Gray Herb. 168:20, 1949), which was based on one of Tom's collections in Oklahoma.

Besides his membership in the California Botanical Society, he was a member of Sigma Xi, the Society for the Study of Evolution, and of the International Association for Plant Taxonomy.

Tom Robbins will long be missed by those whose good fortune it was to know him at all well.—RIMO BACIGALUPI, Jepson Herbarium, Department of Botany, University of California, Berkeley.

STUDIES IN THE PERENNIAL GENTIANS: G. NEWBERRYI AND G. TIOGANA[1]

CHARLES T. MASON, JR.

Gentiana newberryi Gray is the name applied to a group of dwarf perennial gentians of Section Pneumonanthe, which occurs in the Sierra Nevada and Cascade Mountains of California and Oregon. The name is used in many manuals (Abrams, 1951; Jepson, 1925; Munz, 1959; Peck, 1941) to embrace not a single species but two species and a number of intermediate forms. While the author was studying the western perennial gentians under a National Science Foundation grant, the problem came to light, and an attempt is here made to resolve the difficulty.

Asa Gray described *Gentiana newberryi* from material collected in Oregon by Newberry, a member of the Williamson Pacific Railroad expedition of 1855. He first presented the new name in a hand-written description on the type sheet in the Gray Herbarium. Only the Newberry specimen was cited with this description. However, by the time the name was published (Gray, 1876), the circumscription was modified to include California material, and a Bolander collection from Mariposa County was added as a syntype.

Three other names have been applied to this complex. In 1931 Eastwood described *G. copelandii,* which she separated from *G. newberryi* on the "much broader leaves and dark purple flowers." The name *G. copelandii,* having been used previously by Greene (1904) and by Elmer

[1] Arizona Agricultural Experiment Station Technical Paper No. 568.

(1915), was invalid, causing Eastwood to correct the name of this species to *G. eximia* (Eastwood, 1934). A third species, *G. tiogana,* was recognized in 1940 by Heller, who separated it from *G. newberryi* by its smaller size.

Of the three validly published names, *G. newberryi, G. eximia,* and *G. tiogana,* only the first has been accepted by students of the flora of California and Oregon. The present author, after studying many field and herbarium specimens, is convinced that two species should be recognized. They are both perennials with a rosette of leaves and with flowering stalks arising from the axils of last year's leaves. Each flowering stalk usually has a single flower, and the patterning on the flowers is the same; however, the two species can be separated by the following characters:

Flowers 4.0–5.5 cm. long; corolla bright blue with 5 dark greenish stripes, the lobes 1.0–1.5 cm. long; plicae many-lobed with two long thin central lobes 0.7–0.9 cm. long; leaves broadly spatulate to suborbicular . *G. newberryi*
Flowers 2.5–3.5 cm. long; corolla white or very pale blue with 5 dark greenish-brown stripes, the lobes 0.7–0.8 cm. long; plicae 0.4 cm., two-lobed with an occasional third or fourth lobe; leaves lanceolate to narrowly obovate . . . . *G. tiogana*

GENTIANA NEWBERRYI Gray, Proc. Am. Acad. 11:84. 1876. *Pneumonanthe newberryi* (Gray) Greene, Leafl. Bot. Obs. 1:71. 1904. *Dasystephana newberryi* (Gray) Arth. Torreya 22:30. 1922. *Gentiana copelandii* Eastw. Proc. Calif. Acad. Sci. Series 4, 20:150. 1931; non *Gentiana copelandii* Greene, 1904, or Elmer, 1915. *Gentiana eximia* Eastw. Leafl. West. Bot. 1:96. 1934.

Low rhizomatous perennial with a rosette of broadly oblong-spatulate to suborbicular leaves up to 6 cm. long and 2 cm. wide; flowering stems 1–5, decumbent to erect, 15 cm. long, from axils of last year's leaves; flowers 4.0–5.5 cm. long and usually 1 per stem; calyx tube 0.8–1.5 cm. long, the lobes 0.7–1.1 cm. long, lanceolate to elliptical; corolla convolute in the bud, funnelform after anthesis, 4.0–5.5 cm. long, bright blue with 5 dark purple stripes extending from the tips of the lobes to the base of the corolla, the lobes 1–1.5 cm. long, entire or erose, broadly rounded with yellow-green dots on the inner surface and extending down into corolla tube, the apices apiculate; plicae 0.7–0.9 cm. long, bifid with two long attenuate lobes and several secondary lateral projections; stamens maturing before the pistil, the anthers extrorse; style none; capsule ellipsoidal, 1.5 cm. long, the stipe 1.5 cm. long; seeds broadly winged all around.

Type. Crater Pass, west side Cascade Mountains, lat. 44°, Oregon, *Newberry* s.n. (GH). Type was seen.

Gentiana newberryi is known only from the Three Sisters in the Cascade mountain area of central Oregon, and from the Mount Eddy region in Siskiyou and Trinity counties, California. An unexplained distributional gap exists from northern California to central Oregon. A similar disjunct distribution is exhibited by *Limnanthes douglasii* R. Br.

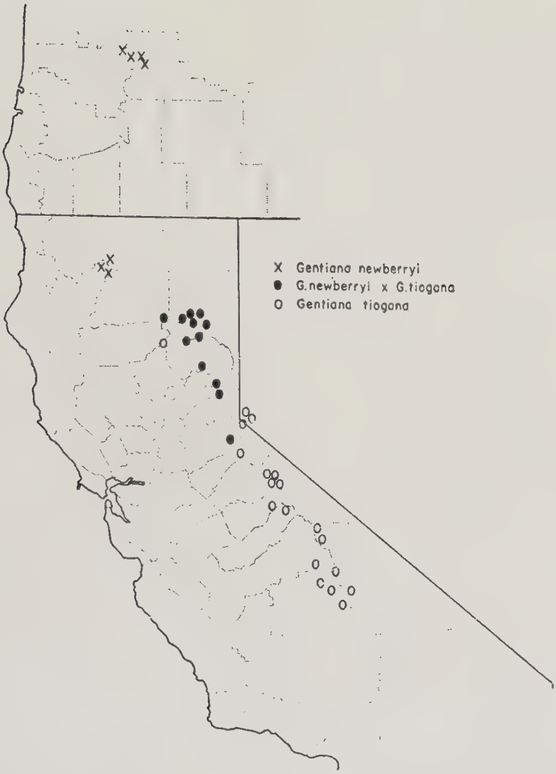

FIG. 1. Distribution of *Gentiana newberryi, G. tiogana,* and their hybrid in Oregon, California, and Nevada.

var. *douglasii,* which has the northern limit of its California distribution in Humboldt County and is again found in the Umpqua Valley, Douglas County, Oregon (Mason, 1952).

Representative specimens. OREGON. Deschutes County: Three Creeks Meadow, *Brandt & Steward 6985* (ID, UTC), *Ellis & C. Mason 1712*; meadow near Three Creeks Lake, *Whited 478* (WS), *Ellis & C. Mason 1711*; Fremont's Crossing of Tumalo Creek, *Whited 479a* (WS). Lane County: 5 miles west of McKenzie Pass, *Campbell 17497* (CAS); Hand Lake, 4 miles west of Lane-Deschutes county line, *T. & C. Mason 1791*.

CALIFORNIA. Siskiyou County: Mount Eddy, *Copeland 3878* (CAS), *Eastwood 2037* (type of *G. copelandii* Eastw., CAS.). Trinity County: Morris Meadow, Stuart Fork, *Alexander & Kellogg 5525* (UC); edge of Bull Lake, *Parker* in 1947 (DS).

GENTIANA TIOGANA Heller emend. C. T. Mason. *G. tiogana* Heller, Leafl. West. Bot. 2:221–222. 1940.

Low rhizomatous perennial with a rosette of obovate to spatulate leaves ca. 4 cm. long and 1 cm. wide; flowering stems 1 or 2, decumbent to erect, 5–7 cm. long, from the axils of last year's leaves; flowers 2.5–3.5

cm. long, usually 1 per stem; calyx tube 0.6–1.0 cm. long, the lobes 0.6–1.0 cm. long, lanceolate to elliptical; corolla convolute in the bud, funnelform after anthesis, 2.5–3.5 cm. long, white or very light blue with 5 greenish-brown stripes extending from the tips of the lobes to the base of the corolla, the lobes 0.7–0.8 cm. long, entire or erose, narrow with yellow-green dots on the inner surface and extending down into corolla tube, the apices apiculate; plicae 0.4 cm., with 2 large lobes and an occasional third or fourth smaller lateral lobe; stamens maturing before the pistil, the anthers extrorse; capsule ellipsoidal, 1.0–1.2 cm. long, the stipe 1.0 cm. long; seeds broadly winged all around.

Type. Shore of a lakelet outside Yosemite National Park, Tioga Pass, Mono County, California, *Heller 15453* (WTU #79272. Isotypes, CAS, DS, NY, UC, WTU). The type specimen was not seen, but the information was transmitted by letter from C. L. Hitchcock. Isotypes from California Academy of Sciences, Dudley Herbarium, and University of California were seen.

Heller's labels agree on the collection number, the date, and that the collection was made outside Yosemite Park boundary. They vary to some degree on the other data presented. The county is listed as either Mariposa or Mono. As the park boundary is also the county line, "outside the park" would be Mono County. The distance outside the park varies from a few yards to one-fourth mile, and the elevation ranges from 9900 to 9940 feet. The labels also state, "south of Tioga Pass entrance"; the park boundary at that particular point extends east and west so that south of the entrance would be inside, not outside, the park. Heller probably considered the general direction of travel from Mono Lake to the Tioga Pass entrance through Leevining Canyon as west; therefore, to the left would be south. In the area to the east of the road at the Tioga Pass entrance is a meadow with a number of lakelets, and it undoubtedly is in this area that Heller made his collection.

The specific epithet *tiogana* was applied by Heller to specimens which, because of their smaller size, he considered distinct from the Sierra Nevada material recognized as *Gentiana newberryi*. This small form has been collected several times from the higher elevations and may warrant varietal recognition, but this author does not consider it distinct enough to be separated as a species; consequently Heller's epithet becomes the first applied to this group and must be used, and his description has been here emended to include the larger forms.

Representative specimens. CALIFORNIA. Inyo County: Big Pines Lake, *Howell 24123* (CAS); Mosquito Flat, Rock Creek, *Halperin 605* (CAS), *Ferris & Lorraine 11086* (DS); Heart Lake, Rock Creek Basin, *Peirson* in 1933 (DS, UC), *Peirson 9483* (COLO); Kearsarge Pass Trail west of Independence, *Alexander & Kellogg 3291* (DS, UC); Brown Lake, *Raven & Stebbins 254* (CAS, UC); Cottonwood Lakes, *Alexander & Kellogg 3316* (DS, UC, UTC). Tulare County: Crabtree Meadows, *H. M. & G. Hall 8442* (UC); Lost Canyon, *Howell 17787* (CAS); Rock Creek, *Howell 25515* (CAS, UC, UTC, WS); Army Pass, *Howell 26045* (CAS); Sequoia-Mount Whitney trail, *Sisson & Kobs* in 1928 (COLO); Humphrey Basin, *Moran 490* (DS). Fresno County: Hilgard Branch, Bear Creek, *Raven 7872* (CAS);

Humphrey Basin west of Mount Humphreys, *C. Sharsmith 3149* (UC). Madera County: Iron Creek, *Raven 3809* (CAS). Mariposa County: Mount Hoffman, *Rodin 885* (UC). Mono County: Slate Creek, Hall Natural Area, *Clausen 920* (DS, UC), *C. Mason 1514*; Dana Meadow, Tioga Pass, *Rowntree* in 1931 (CAS); ½ mile upstream from Camp Tioga along Slate Creek, *C. Mason 1512*; southwest end Little Virginia Lake, *Hendrix 604* (UC); Soda Springs, Tuolumne Meadows, *Eastwood 625* (CAS); Bourland Meadows, *Belshaw 81* (UC); Dana Plateau, northwest of Mount Dana, *C. Sharsmith 2331* (UC); White Mountain, Mount Conness Range, *H. Mason 11339* (UC); Ten Lakes Basin, *H. Sharsmith 1329* (UC); near Dog Lake, *Howell 20434* (CAS). Alpine County: meadow 3 miles west of Lake Alpine, *C. Mason 1610*. Eldorado County: Benwood Meadows, Camp Echo, *Heller 12264* (CAS, COLO, DS, UC); Dicks Lake, Lake Tahoe, *Alexander & Kellogg 3508* (UC); Meyers Station, *Clemens* in 1920 (CAS). Butte County: Jonesville, Spring Creek, *Copeland* in 1931 (UC). NEVADA. Washoe County: 3 miles south Mount Rose, *Hitchcock & Martin 5542* (DS, UC, UTC, WS); Galena Creek, south base Mount Rose, *Hitchcock & Martin 5522* (DS, UC, UTC); Mount Rose, *Heller 9970* (CAS, DS, MONTU).

Naturally and artificially produced hybrids among the gentians are well-known (Mason, 1959), and a number of herbarium specimens from northern California show evidence of hybridization and introgression between *G. tiogana* and *G. newberryi*. Three collections from Eldorado County (Wrights Lake, *Johannsen 452*, UC; ½ mile north of Wrights Lake, *Robbins 1355*, CAS, UC; and Echo Summit, *Howell 22974*, CAS) have the characteristics of *G. tiogana* except that the plicae tend to be long and narrow.

Several collections from Nevada, Sierra, Plumas, Lassen, and Shasta counties in California have characteristics of both species. Specimens from Sage Hen Creek (*H. Mason 14472*, UC), and Independence Lake (*Floyd* in 1925, CAS, *Alexander & Kellogg 5160*. UC), of Nevada County, and Webber Lake, Sierra County (*Dudley* in 1894, DS) have stem length, leaf size but not shape, and plicae lobing which approach those of *Gentiana newberryi*. The flower size is intermediate, ranging from 3.5–4.3 cm. on the collections from Independence Lake, and 3.8–4 cm. on the other two collections. The plicae are of the larger type found in *G. tiogana*, and the green and white flower color of that species is specified on Mason's collection. Possibly the larger size of the leaves and stems is the result of ecological rather than genetic factors.

A sheet of specimens from Mount Elwell, Plumas County (*Wicks 2889*, UC), has flowers and leaves approaching those of *G. newberryi*. The flowers are 4–4.5 cm. long and the calyx lobes are large and elliptic. The plicae, although multilobed, are the large type of *G. tiogana*. The flower color is not specified, but the specimens appear dark as though there may be some blue factors present. One plant on the sheet is quite different from the others; it has the smaller flowers, smaller leaves, white color, and heavy plicae of *G. tiogana*. The presence of the two types in the same collection gives good evidence that both are present in the same area so that hybridization might occur between the two species.

Several collections from northern Plumas County (Big Meadows, *Coombs* in 1912, CAS, UC, *Austin 399*, UC; Prattville, *Coombs* in 1906, CAS), southeastern Shasta County (Lassen's Peak, *Brewer 2175*, UC;

upper King's Creek Meadow, *Hoover 4612*, UC), and southwestern Lassen County (Susanville, *Safford* s.n., UC; Mountain Meadows, *Austin* in 1879, UC; Hog Flat, *Stebbins* et al *3998*, UC; Harvey Valley Spring, *Whitney 1505*, UC; a mile east of Westwood, *Heller 15341*, DS, UC) show evidence of introgression. Of particular interest are the two collections from Big Meadow which have several flowers per stem. This multiple flower condition is uncommon in either of these parent species, but it is seen on some collections by Lemmon which are affixed to the type sheet of *G. newberryi*. Undoubtedly these Lemmon collections were made from this northern California area, although the data on the label are vague and incomplete. The Brewer collection from Mount Lassen and Safford's collection from Susanville have very small plants and flowers and show more of the characters of *G. tiogana* than *G. newberryi*.

The two species under consideration are usually separated by altitudinal differences. Most collections of *G. newberryi* have come from areas between 4000 and 6500 feet in elevation, but one specimen from Bull Lake, Trinity County, California (*Parker* in 1947, DS) is listed as 7380 feet. *Gentiana tiogana* frequently is found above timberline, and specimens from 12,000–13,000 feet are not uncommon. The lowest elevation noted for a collection of *G. tiogana* is 7160 feet at Jackass Meadow, Fresno County (*Peirson 12880*, CAS).

The specimens cited as having characteristics of both species have been collected from areas which, for the most part, are intermediate in elevation between the usual requirements of the two parents. The collection of specimens from "a mile east of Westwood," *Heller 15341*, is cited as elevation 5000 feet, and these plants are predominantly of the *G. newberryi* type. On the other hand the collection from Lassen's Peak, *Brewer 2175*, was made at 8000 feet, and these specimens have the majority of their characters similar to *G. tiogana*. This overlap in the altitudinal distribution of intermediate forms might also be regarded as evidence that *G. newberryi* and *G. tiogana* hybridize in northern California.

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CHROMOSOME COUNTS IN THE SECTION SIMIOLUS OF THE GENUS MIMULUS (SCROPHULARIACEAE). IV.

Barid B. Mukherjee and Robert K. Vickery, Jr.

This report[1] on the determination of chromosome numbers in the section *Simiolus* of the genus *Mimulus* is part of a long range investigation into the evolution of species in *Mimulus* (Vickery, 1951). The chromosome numbers and configurations presented in this article indicate a lack of cytological differentiation between several of the currently accepted species (Pennell, 1951) of the section *Simiolus*. Also they reveal the presence of aneuploidy in different populations of two other species, and, lastly, they fill an important gap in the previously indicated (Mukherjee and Vickery, 1959) polyploid series that extends from North to South America.

Essentially the same method of bud fixation was employed as in the previous investigation (Mukherjee and Vickery, 1959), i.e., fixation in two parts absolute ethanol to one part glacial acetic acid saturated with ferric acetate, followed by staining of the anthers in iron-aceto-carmine. Work now in progress indicates that there may be possible improvements in this schedule. Each chromosome number determination is based on counts from an average of approximately eight pollen mother cells. Camera lucida drawings were made for three or four figures for each count and, in addition, photomicrographs were taken of many of the configurations. Herbarium specimens of each culture have been or will be deposited in the Garrett Herbarium of the University of Utah (UT).

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FIG. 1. Meiotic chromosomes of *Mimulus*: *M. guttaus*, 5014, 5091, 5382, 5836, 5864; *M. tilingii* var. *tilingii*, 5012, 5690, 6117; *M. laciniatus*, 5339; *M. laxus*, 5658; *M. nasutus*, 5044, 5018, 5327; *M. platycalyx*, 5752; *M. glabratus* var. *utahensis*, 6062; *M. glabratus* var. *fremontii*, 5063, 5373; *M. tigrinus*, 5081; *M. luteus*, 5042, 5043. All cells are in or near second metaphase except 5382, 5836, 5012, 5690, 5658, 5018, and 5752, which are in first metaphase. (Camera lucida drawings as reproduced, = × 840).

A total of thirty-three cultures was studied during the present investigation (see table 1). They include representatives of ten species and varieties of the section *Simiolus*: *Mimulus guttatus* DC., *M. tilingii* Regel var. *tilingii*, *M. laciniatus* Gray, *M. nasutus* Greene. *M. laxus* Pennell, *M. platycalyx* Pennell, *M. glabratus* var. *utahensis* Pennell, *M. glabratus* var. *fremontii* (Benth.) Grant, *M. tigrinus* hort., and *M. luteus* L.

All fifteen cultures of *M. guttatus* were found to have n=14 chromosomes. The configurations were regular and similar to those previously observed for other cultures of *M. guttatus* (Vickery, 1955; Muhkerjee, Wiens, and Vickery, 1957; Mukherjee and Vickery, 1959) and, therefore, only a few of the camera lucida drawings of *M. guttatus* chromosomes were included in figure 1. The fifteen cultures examined represent much of the geographical range of *M. guttatus* (see table 1) and much of its morphological and physiological diversity as well. Morphologically the cultures differ from each other in the average height of the plants, shape of the leaves, amount and distribution of anthocyanin pigmentation, and in the size of the flowers. Physiologically they differ in growth rates, time and speed of flowering, and time and speed of maturing seeds. Cytologically the only detectable difference observed among the fifteen cultures was the presence of marked chromosome stickiness under the present fixation schedule in two of the annual races. Despite the wide range of morphological and physiological differences between the various cultures, they all exhibit apparently similar karyotypes.

The chromosome numbers of six cultures of *M. tilingii* var. *tilingii* from the Sierra Nevada (see table 1) were found to be n=14 as in *M. guttatus*. *Mimulus tilingii* var. *tilingii* is related to *M. guttatus* on the basis of morphology (Hitchcock, Cronquist, Ownbey and Thompson, 1959), but is separated from it by strong crossing barriers (Vickery, 1956). The chromosome configurations of the six cultures were regular and similar to those of *M. guttatus* and to our first *M. tilingii* var. *tilingii* count (Vickery, 1955), but differed in number from our more recent report of n=15 for a Utah population of *M. tilingii* var. *tilingii* (Mukherjee and Vickery, 1959). The populations studied represent much of the morphological diversity present in *M. tilingii* var. *tilingii* in the Sierra Nevada (table 1).

Mimulus laciniatus and *M. laxus*, species that are genetically closely related to *M. guttatus* (Vickery, 1956, and unpublished), were found to have n=14 chromosomes as does *M. guttatus*. The karyotypes of the three species are apparently indistinguishable. *Mimulus laciniatus* is morphologically strikingly different from *M. guttatus*, whereas *M. laxus* is closely similar. Probably *M. laciniatus* should be treated as a variety of *M. guttatus*, while *M. laxus* should be considered as synonymous with *M. guttatus*.

The chromosomes of three cultures from widely scattered populations (see table 1) of *M. nasutus* were counted. Two of the cultures have n=13 chromosomes and the third has n=14, which confirms the previous de-

TABLE 1. CHROMOSOME COUNTS IN MIMULUS, SECTION SIMIOLUS

n=14 *M. guttatus* DC.

Barry Summit, Humboldt County, California, altitude 3,400 feet, *Keck 6007* (5005).

Yosemite Junction (rocky creek), Tuolumne County, California, altitude 1300 feet, *Hiesey 560* (5006).

Lee Vining Canyon, Mono County, California, altitude 8000 feet, *Clausen 2039* (5014).

Kern River, Kern County, California, altitude 1000 feet, *L. Bean*, April 16, 1949 (5085).

Botanic Garden strain, Hortus Cluj, Romania (5091).

Rio Santo Thomas, Baja California, Mexico, altitude ca. 20 feet, *C.* and *L. Hubbs,* spring 1950 (5382).

San Dimas Canyon, Los Angeles County, California, altitude 1500 feet, *R. K. Vickery, Jr.,* September 29, 1950 (5678).

Hugh's Canyon, Salt Lake County, Utah, altitude 6000 feet, *N. Chamberlain,* spring, 1952 (5836).

Skagg's Springs, Sonoma County, California, altitude ca. 50 feet, *R. Holm,* spring, 1951 (5864).

Old Mine, Big Cottonwood Canyon, Salt Lake County, Utah, altitude 7650 feet, *Vickery 683* (5961).

Neff Canyon, Salt Lake County, Utah, altitude 5500 feet, *D. Wiens,* September 6, 1956 (5995).

Moab, Grand County, Utah, altitude 4100 feet, *Vickery 762* (6080).

Cane's Spring, San Juan County, Utah, altitude 5800 feet, *Vickery 763* (6081).

Ledgemere, Big Cottonwood Canyon, Salt Lake County, Utah, altitude 5100 feet, *Vickery 880* (6082).

East Creek, Morgan County, Utah, altitude 5700 feet, *Vickery 883* (6083).

n=14 *M. tilingii* Regel var. *tilingii*

Slate Creek (near Carnegie Transplant Garden), Mono County, California, altitude 10,000 feet, *Clausen 2075* (5012). (In flower at time 6120, 6121, 6122 were collected in bud.)

Budd Lake, Tuolumne County, California, altitude 10,250 feet, *C. W. Sharsmith,* September 13, 1950 (5690).

Tributary to Slate Creek (near Carnegie Transplant Garden), Mono County, California, altitude 10,050 feet, *Vickery 1379* (6117).

Slate Creek (near Carnegie Transplant Garden), Mono County, California, altitude 10,000 feet, *Vickery 1382* (6120). (Light green, large leaves.)

Same locality—*Vickery 1383* (6121), dark green, medium sized leaves.

Same locality—*Vickery 1384* (6122), dark green, small leaves.

n=14 *M. laciniatus* Gray

Lake Eleanor road, Tuolumne County, California, altitude 4200 feet, *Vickery 179* (5339).

n=14 *M. laxus* Pennell

Yreka, Siskiyou County, California, altitude 3000–3200 feet, *Pennell 26163* (5658).

n=14 *M. nasutus* Greene

Hasting's Reservation, Monterey County, California, altitude 1500 feet, *Stebbins 701* (5044).

n=13 *M. nasutus* Greene

San Augustine Pass, Dona Ana County, New Mexico, altitude 4500 feet, *O. Norwell,* October 30, 1946 (5018).

Wild Cat Creek, near Yosemite Junction, Tuolumne County, California, altitude 475 feet, *Vickery 168* (5327).

n=15 *M. platycalyx* Pennell
Crystal Lakes Reservoir, San Mateo County, California, altitude 800 feet, *G. Oberlander,* April, 1951 (5752).
n=15 *M. glabratus* var. *utahensis* Pennell
Johnson Pass, Tooele County, Utah, altitude 5800 feet, *D. Wiens,* October, 1956 (6062).
n=30 *M. glabratus* var. *fremontii* (Benth.) Grant
Whipple Mountains, San Bernardino County, California, collected April 21, 1940. U.C. 667,449 (5063).
Kakernot Springs, Alpine Creek, Brewster County, Texas, *Cory 53186,* May 18, 1946 (5373).
n=32 *M. tigrinus* hort.
Garden seed from the "Carlos Thays" Botanic Garden, Buenos Aires, Argentina (5081).
n=32 *M. luteus* L.
Vicinity of Illapel, Coquimbo, Chile, altitude 6200 feet, *Plant Introduction and Exploration Division (U.S.D.A.) no. 144,535* (5042).
n=30+0, 1, or 2 *M. luteus* L.
Vicinity of Illapel, Coquimbo, Chile, altitude 2000 feet, *Plant Introduction and Exploration Division (U.S.D.A.) no. 144,536* (5043).

termination by G. L. Stebbins, Jr. (personal communictation) for the same culture. The n=13 cultures exhibit partial crossing barriers with *M. guttatus*, whereas the n=14 culture crosses readily with *M. guttatus* (Vickery, 1956, unpublished). The cytologic and crossing results suggest to us that *M. nasutus* as presently described (Grant, 1924, and Pennell, 1951) includes at least two different entities. The proper naming of these entities must await further investigation and a detailed study of the taxonomic literature and type specimens of *M. nasutus* and and its relatives.

Culture 5752, which was found to have n=15 chromosomes, was identified as *M. platycalyx* with some misgivings. Although the plants clearly exhibit Pennell's main key character of "fruiting calyces being fully as wide as long," yet the corolla throats are open and not filled by "a palate nearly closing orifice" (Pennell, 1951). Furthermore, Pennell had described *M. platycalyx* as occurring in the "southern Sierra Nevada from Mariposa to Tulare County, California," whereas the plants from which culture 5752 were grown came from the Crystal Lakes region of the outer Coast Ranges of California. However, even if this culture does not properly belong to *M. platycalyx*, it does represent an entity that is distinct from *M. guttatus* on the basis of morphology, crossing behavior (Vickery, 1956, in press), and cytology. Here again a sound taxonomic decision must await further critical study of this entity and the literature.

The culture of *M. glabratus* var. *utahensis* (6062) from the Stansbury Mountains near the Great Salt Lake had n=15 chromosomes as did culture 5265 from the population at Bicknell, Wayne County, Utah (Mukherjee, Wiens, and Vickery, 1957). In contrast, the population from the shore of Mono Lake at the western edge of the Great Basin has n=14 chromosomes (Vickery, 1955). Perhaps *M. glabratus* var. *utahensis* also

consists of two morphologically similar but cytologically different entities as does *M. nasutus,* although corroborative crossing data is not yet available.

Two cultures of *M. glabratus* var. *fremontii* from southern California and Texas were found to have n=30 chromosomes, although some of the plants of culture 5063 were observed to have as few as n=26 chromosomes. This chromosome number fills an important gap in the polyploid series connecting the Great Basin form, *M. glabratus* var. *utahensis,* n=14 and n=15, with the South American *M. glabratus* var. *parviflorus* (Lindl.) Grant, n=45, and its ally *M. pilosiusculus* HBK., n=46 (Mukherjee and Vickery, 1959). *Mimulus glabratus* var. *fremontii* is approximately intermediate in appearance between the other two varieties. It is 5 to 15 centimeters in height, whereas *M. glabratus* var. *utahensis* varies from 10 to 50 centimeters, and *M. glabratus* var. *parviflorus* is nearly prostrate. The leaves and flowers of *M. glabratus* var. *fremontii* are smaller than those of *M. glabratus* var. *utahensis* but larger than those of *M. glabratus* var. *parviflorus.* A broader cytogenetic and taxonomic study of the *Mimulus glabratus* complex of species is now being undertaken.

The culture of *M. tigrinus* from the Botanic Garden of Buenos Aires, Argentina, was found to have n=32 chromosomes. This count agrees with the previous reports of Brozek (1932), Sugiura (Darlington and Wylie, 1955) and the authors (1959).

Chromosome counts obtained for two different cultures of *M. luteus* tend to support the previously indicated relationship of the horticultural species, *M. tigrinus,* to this wild species (Mukherjee and Vickery, 1959). Culture 5042 has n=32 chromosomes on the basis of two plants studied whereas culture 5043 was variable on the basis of the five or six plants examined. Of the twenty-three cells studied eleven had n=30 chromosomes, six had n=31 and six had n=32. The cause of the variability was not clear from the data obtained. Perhaps accessory chromosomes are involved. Tentatively, the chromosome number for this culture appears to be n=30+0, 1 or 2. The two cultures of *M. luteus* are morphologically similar, but are distinguishable on the basis of flower markings and the general growth habits of the plants.

In conclusion, this survey of chromosome numbers in section *Simiolus* has verified previously published counts for *M. guttatus* (n=14), *M. tilingii* var. *tilingii* (n=14, *M. glabratus* var. *utahensis* (n=15) and *M. tigrinus* (n=32). It has shown that two species that are genetically closely related to *M. guttatus, M. laciniatus* and *M. laxus,* have n=14 chromosomes also. In contrast, the culture, tentatively assigned to *M. platycalyx,* which is morphologically closely related to *M. guttatus* but genetically partially separated from it, has n=15 chromosomes. *Mimulus nasutus* appears to consist of two entities, one with n=14 chromosomes that is genetically closely related to *M. guttatus,* and the other with n=13 chromosomes that is genetically partially isolated from *M. guttatus* and from the n=14 form of *M. nasutus. Mimulus glabratus* var. *fremontii*

was found to have n=30 chromosomes, which neatly fills an important gap in the polyploid series of *M. glabratus* var. *utahensis*, n=15, to *M. glabratus* var. *parviflorus*, n=45. Lastly, one race of South American *M. luteus* has n=32 chromosomes, as had been previously reported for its horticultural derivatives, but the other race apparently has n=30+0, 1, or 2.

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FLOWERING RESPONSES IN PHACELIA SERICEA AND P. IDAHOENSIS[1]

George W. Gillett

In the study of variation in the *Phacelia sericea* complex [*P. sericea* (Graham) A. Gray subsp. *sericea*; *P. idahoensis* Henderson; and intermediates], experimental cultures of *P. sericea* subsp. *sericea* and of *P. idahoensis* could not be brought into flower under actual or simulated summer conditions. In these cultures, the daily photoperiod was extended by incandescent lights, when necessary, to between 16 and 20 hours. Later cultures were brought into flower, however, by simulating the fall conditions of the natural environment to the extent of materially reducing

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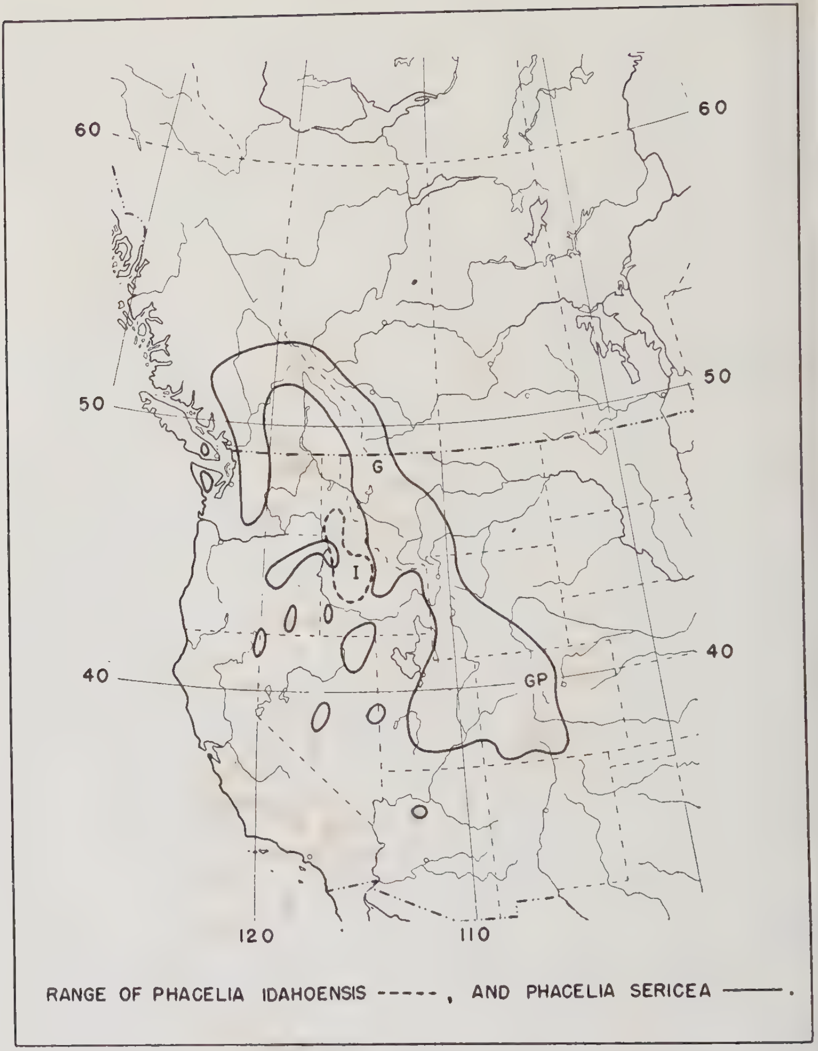

FIG. 1. Geographical distribution of *Phacelia sericea* and *Phacelia idahoensis*. Races employed in experimental cultures: *P. idahoensis* (I), Valley Co., Idaho. *P. sericea* subsp. *sericea*: (G), Glacier Co., Montana; (GP), Routt Co., Colorado. Base map courtesy of University of Chicago Press.

the length of the photoperiod and, at the same time, providing a cool temperature regime (Table 1). The data obtained from these cultures could be of value to those interested in growing alpine perennials experimentally, inasmuch as they show that certain alpines can be manipulated into flowering in a relatively short time.

Both *Phacelia sericea* and *P. idahoensis* are spring-flowering perennials.

Early growth in each species is marked by the formation of a leaf rosette at ground level, with a virgate inflorescence axis later arising from the center of the rosette. In respect to geographical distribution (fig. 1), *P. sericea* occurs in the Rocky Mountains, the northern Cascades, the Olympics, and the ranges of the northern Great Basin. It is common at higher elevations, occurring on exposed gravel banks and talus slopes from 4500 feet, in the Canadian Rockies, to 13,000 feet in southern Colorado. By contrast, *P. idahoensis* is restricted to central Idaho, where it is found between 2800 and 7000 feet on wet meadows, stream banks, and on bottomlands subject to seasonal flooding.

Limited field studies made on colonies of *Phacelia sericea* subsp. *sericea* have produced some information about the flowering response in this cordilleran subspecies. In several colonies examined in Colorado, Wyoming, and Montana, there was a pronounced tendency for early summer flowering, and for the simultaneous expression of a given phase of flowering by both large and small plants within a given colony. Furthermore, widely-separated colonies that were examined on the same day exhibited similar stages of inflorescence development. These points were convincingly emphasized by an extensive and unsuccessful search for meiotic flower buds in several flowering colonies in Glacier County, Montana. In this area, and in Park County, Wyoming, colonies separated by as much as 1000 feet of elevation were found in similar stages of flowering.

The examination of collection data from over 800 herbarium sheets of *Phacelia sericea* and *P. idahoensis* confirmed the above field observations. In both species, there is a very strong tendency to early summer flowering, and general uniformity in the stage of inflorescence development in specimens of a given collection. The sum total of this evidence would, therefore, suggest that flowering in these species is "triggered" by a broadly imposed environmental stimulus or stimuli, and it would tend to rule out the possibility that these are day-neutral species.

Three races of these species were included in the present study. They were grown in experimental cultures (see Table 1) from seed collected in the following localities:

Phacelia sericea subsp. *sericea*

Gore Pass. Newly-graded road shoulder, highway 84, Routt County, Colorado, 9.9 miles west of Gore Pass, elevation ca. 8000 feet, *Gillett 1145* ("GP" in fig. 1).

Glacier. Gravel road shoulder, 0.8 miles west of Many Glacier Entrance Station, Glacier National Park, Glacier County, Montana, elevation 4800 feet, *Harry Robinson s.n.* ("G" in fig. 1).

Phacelia idahoensis

Moist bottomlands 2.9 miles south of Donnelly, Valley County, Idaho, elevation 4800 feet, *James Hockaday s.n.* ("I" in fig. 1).

Voucher specimens of experimental plants have been deposited at the herbaria of Michigan State University and the University of California, Berkeley.

TABLE 1. FLOWERING RESPONSES IN PHACELIA IDAHOENSIS AND P. SERICEA

I. Plants given *long-day cycles only.*

A. Approximately 155 long-day cycles between October and March, 18–20 hour photoperiods. Temperatures between 10° and 25°C.

	No. Plants	*Flowered*
P. idahoensis	9	0
P. sericea (Gore Pass)	8	0
P. sericea (Glacier)	5	0

B. Approximately 180 long-day cycles between April and September; with 14–16-hour photoperiods. Temperatures between 15° and 30°C.

P. idahoensis	20	0
P. sericea (Gore Pass)	10	0
P. sericea (Glacier)	10	0

C. Approximately 250 long-day cycles between February and October; with 14-16-hour photoperiods. Temperature between —3° and 35°C.

P. idahoensis	8	0
P. sericea (Glacier)	4	0

II. Plants given *long-day cycles (14–16 hr. photoperiods) followed by short-day cycles.*[a]

A. Approximately 110 long-day cycles (temp. regime of I.-C) followed by 23 short-day[b] cycles terminated by 22 cycles of 16-hour photoperiods under 14°C. days and 7°C. nights, the 155-days-old plants then placed in a greenhouse (mid-July), with no supplementary light.

	No. Plants	*Flowered*	*Days to flowering after short-day treatment*
P. idahoensis	8	8	16
P. sericea (Glacier)	4	2	12

B. Approximately 163 long-day cycles (temp. regime of I.-C) followed by 65 short-day[c] cycles, the 228-days-old plants then placed in a greenhouse (mid-September), with no supplementary light.

P. idahoensis	3	3	19
P. sericea (Glacier)	2	1	16

C. Approximately 169 long-day cycles (temp. regime I.-C) followed by 59 short-day[c] cycles, the 228-days-old plants then placed in a greenhouse (mid-September), with no supplementary light.

P. idahoensis	3	3	23
P. sericea (Glacier)	2	1	23

[a] short-day cycles given inside a walk-in refrigerator with incandescent lights under temperature regime of 14°C. days and 7°C. nights.
[b] 10-hour photoperiods.
[c] 8-hour photoperiods.

Culture techniques included germinating seeds in moist vermiculite, then transplanting young (ca. two weeks old) seedlings to four-inch pots holding equal parts of sterilized, screened river sand and peat moss. The plants were fed a nutrient solution (2 oz. commercial fertilizer per gallon of tap water) once a week through a siphon connection to the watering hose.

The light and temperature regimes provided for these cultures are given in Table 1. The results obtained indicate that *Phacelia sericea* subsp. *sericea* and *P. idahoensis* are neither day neutral nor "nominal" long-day plants. The positive flowering responses obtained in all cultures given the combination of cool temperatures and short photoperiods would suggest that these are obligate short-day species; although the possibility of their being conditioned for flowering by low temperatures, independent of day length, remains very strong.

In a final experiment, seven plants of *Phacelia idahoensis* that had been held to long photoperiods of from 14 to 16 hours for 264 days were placed in an open cold frame and exposed to the late fall light and temperature regime of central Michigan. These conditions included temperatures ranging from +10° to −10°C. After 37 days of "outside" weather, these plants, the pots frozen solid, were removed to the greenhouse. Six of the seven plants produced inflorescences and flowered within a month. These inflorescences were formed in a greenhouse where unaltered December lighting conditions prevailed, demonstrating (as indicated in II-C of Table 1) that this species does not require, subsequent to induction, a long-day regime for flowering. It would seem practicable, therefore, to culture this species by a schedule that would include spring germination, and a fall induction period under a cool temperature regime, with the prevailing light of approximately 40° north latitude. It is probable that these suggestions also apply to *P. sericea* subsp. *sericea* inasmuch as its flowering response is similar. A close relationship is indicated by the genetic compatibility between the two taxa, the F_1 hybrids being highly fertile and also flowering after short-day induction treatments.

In addition to providing knowledge for the successful culture of these and probably other species of alpine perennials, these experiments leave a pointed suggestion for plant geographers, namely, that *Phacelia sericea* subsp. *sericea*, a northern alpine perennial, has, in terms of photoperiod requirements, southerly rather than arctic affinities. This would not be surprising in view of the fact that the great bulk of *Phacelia* species are found south of 40° north latitude, while only two species occur farther north than *P. sericea* subsp. *sericea*.

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REVIEWS

Illustrated Flora of the Pacific States. Washington, Oregon, and California. Volume IV—Bignoniaceae to Compositae. By Roxana Stinchfield Ferris. xiii + 732 pages, 1124 figures, and an appendix (for all four volumes) with key to families, index to common names, and index to scientific names. Stanford University Press, Stanford, California. 1960. $17.50.

In 1923, with the publication of Volume I, Ophioglossaceae to Aristolochiaceae, of the "Illustrated Flora of the Pacific States," Leroy Abrams launched his life's work—an illustrated, descriptive flora of all vascular plants known to grow wild in the three Pacific states—Washington, Oregon, and California. Now, thirty-seven

years later, with the publication on January 22, 1960, of Volume IV, Bignoniaceae to Compositae, by Roxana Stinchfield Ferris, the monumentally conceived project is completed and a milestone in the floristic botany of the western states is achieved. Although the task outlasted the life-time and efforts of Professor Abrams, who died in 1956 after about eight years of failing health, he was very fortunate in having the collaboration and devoted assistance of Mrs. Ferris almost from the beginning of the project, and progress on the flora continued uninterruptedly through the years. Mrs. Ferris gave increasing effort to Volume II, Polygonaceae to Krameriaceae, published in 1944, and the task fell upon her of finishing Volume III, Geraniaceae to Scrophulariaceae, published in 1951. She had the entire responsibility for Volume IV. That the finished work ably carries out the objectives stated in Volume I—"to furnish an authentic reference book that will be of greatest service not only to the trained botanist but to everyone interested in the native plant life of the Pacific States."—is tribute not only to Professor Abrams' vision and high level of scholarship but also to Mrs. Ferris' devoted and able efforts toward full realization of his goals.

The "Illustrated Flora of the Pacific States" was designed to duplicate for western botany what Britton and Brown, in their "An Illustrated Flora of the Northern United States, Canada and the British Possessions," had done for eastern botany. These are the only two great North American floristic works in which all species are illustrated and in which the illustrations share along with keys and descriptions the task of species identification. Abrams not only followed the general pattern set by Britton and Brown, but, at first, also followed them in their use of the "American Code" for nomenclature. With the adoption of the International Code after the international congresses of 1930 and 1935, however, the two "codes" were brought almost into accord, and in the 1940 reprinting of Volume I of his flora, Abrams made such generic changes as were necessary to bring his nomenclature into conformity with the International Rules.

In all four volumes specialists were invited to contribute the text for certain plant groups, and in Volume IV Mrs. Ferris had the able assistance of ten such collaborators. In addition she was fortunate in being able to base her treatment of the Compositae as a whole upon extensive manuscript notes from the late Dr. Sidney Fay Blake, who had originally planned to contribute the entire text for this family. Mrs. Ferris wrote the major part of the volume herself, however, and, in many groups such as *Baeria, Plantago,* and *Galium,* to name a few, she made significant contributions toward clarification of our understanding of the species.

The illustrations deserve especial consideration inasmuch as they are an integral part of the plan of the entire work. In Volume IV, following the general plan of preceding volumes, the illustration for each species consists of a group of carefully arranged line drawings occupying a rectangle about 2 x 3 inches. There may be two or three or as many as eight separate drawings artistically combined within the given rectangle in such a way as to give both overall aspect or habit of the plant and significant structural details, a combination necessitating much ingenuity and skill. These illustrations of species are then grouped six to a page, or in some cases two or four illustrations may occupy a third or two-thirds of a page. It is stated in the preface that the illustrations, except for the structural features, are half size unless otherwise marked. Legends are confined to binomials, but the pertinent information in the carefully worded text is close at hand, the illustrations and descriptions thus complementing each other and obviating the need for detailed legends. Most of the drawings in Volume IV were made by Jeanne Russell Janish, who was also the artist for many of the illustrations in volumes II and III. Many of the drawings of the Compositae in Volume IV, however, were made by Doris Holm Blake while her husband, Sidney Fay Blake, was working upon what he then hoped would culminate in his full text for the Compositae. The drawings for *Agoseris* and *Helianthus* were made by other artists under supervision of the specialists who contributed the texts for these genera. Except for a few cases where detail is obscured by the illustrations being overly black, reproduction is excellent.

Throughout the volume the keys are skillfully and evenly handled despite the number of different contributors. There are some unfortunate instances of the use of a negative rather than a truly opposing phrase in the second branch of a key dichotomy, but understandably these instances occur particularly in the "difficult" groups. One of the major tasks in preparation of Volume IV was the assembling of an appendix for all four volumes. This contains 1) a key to the families, 2) an index of common names, and 3) an index to scientific names. The family key gives not only the family numbers but also the volume and page on which each family is found, a very necessary aid in a work of this magnitude. The index to common names (there is a common name for every species treated in the four volumes) has the family names printed in small capitals and the genera in Roman type. The index to scientific names is much longer and more complicated than that to common names, having approximately 17,500 entries occupying 79 pages. It has the names of families and tribes printed in small capitals, the genera, species, subspecies, and varieties in Roman type, and the synonyms in italics, all appropriately indented. Because some groups have a great number of species as well as many generic and specific synonyms, the genera in the index to scientific names are not always easy to locate. Possibly greater indentation or perhaps the use of boldface type for generic names would have made them stand out more, although to do this would have necessitated a departure from the style of the previous volumes.

The Stanford University Press has achieved another outstanding accomplishment in typography, printing, and binding, and the volume contains a minimum of typographical and other mechanical errors.

Dr. Bacigalupi, curator of the Jepson Herbarium, has given me permission to quote from the unpublished field notebook of Willis Linn Jepson, whose entry for February 3, 1910, reads: "I am just receiving the first reviews of my Flora of California, Pts. 1 and 2. The critics mostly or even entirely confine themselves to verbal slips, not touching general principles. It is, to be sure, disconcerting enough to have such errors, but after all the main thing is this: 'Has the book got matter in it? Has it got stuff in it? Is it meaty? Not is it *faultless*. A faultless book is impossible. It is inevitable in the nature of the human mind that such slips will be made, mistakes and blunders. But is the job a big one, is it really worthwhile? So satisfied am I in the affirmative that it is a big task, to be done in a big way, without too much considering the danger of possible minor errors, that I go on, to finish up my job, just as other big jobs have been finished aforetime.' "

All will agree that Mrs. Ferris' job has got matter, stuff, and meat in it, that it was a big task, done in a big way.—HELEN K. SHARSMITH, Department of Botany, University of California, Berkeley.

Experimental Studies on the Nature of Species. IV. *Genetic Structure of Ecological Races*. By JENS CLAUSEN and W. M. HIESEY. Carnegie Institution of Washington Publication 615. Washington, D.C. Octavo, vii + 312 pp., 33 figs. 1958. Paper $4.25, cloth $4.75.

This is the fourth in the series of scholarly monographs based on the studies of plant evolution conducted by these authors over the past three decades. This newest volume expands the earlier work on the evolutionary importance of ecological races by considering in detail the genetics of the altitudinal races of *Potentilla glandulosa* and then reviewing examples from the literature on the genetic structure of ecological races.

The volume is organized into five chapters and although these are skillfully interrelated they are sufficiently distinct and different to require individual comment. Chapter I, *Ecological Races of P. glandulosa,* introduces the general topic of the volume by presenting what might be called the systematics of *P. glandulosa* as it occurs along the altitudinal transect across central California. This adroitly prepared chapter makes it possible to read the work without reviewing the previous publications by these authors on *P. glandulosa*. Chapter II, *Genetics of Ecological Races,*

comprises nearly one third of the entire work. The first portion describes the crosses made between selected plants of the various climatic races of *P. glandulosa* by giving in detail the characteristics of the parental plants and the segregation of these characteristics in the F_1, F_2 and F_3 generations. Of particular interest here is the use of punched cards for recording and analyzing the data on 14 different characteristics of each individual plant in these crosses. The inherent nature of the punched card system gave an index number series for each character and a summation of these gave an index value for each plant that proved useful in the general comparison of parents and their progenies. Frequency distribution of parent index values and hybrid index values are presented and give a picture of the spectrum seen in the segregation of the F_2 from the crosses between the contrasting ecological races. The second section of Chapter II presents analyses of the segregation ratios by proposing gene systems that could account for the complex ratios observed. These analyses are detailed to the point of proposing for each characteristic the number of loci involved, the number of alleles at each locus, and the action and interactions of the various genes. The significance of these proposed gene systems lies not in their accuracy as to details but rather lies in the fact that viewed collectively they demonstrate that the differences between the ecological races are controlled by units of segregation and recombination that can be described in terms of classical genetics. These points are clearly expressed in the concluding chapter.

Chapter III, *Response Patterns at Contrasting Altitudes,* analyzes the responses of cloned individuals of an F_2 between two ecological races to the different environments of the transplant stations. Studying such an F_2 under different natural environments leads the authors to estimate the evolutionary potential of segregating populations. They conclude this important chapter with the following: "The present races are the products of long-time selection, and have attained an equilibrium with their environments. Natural selection will therefore tend to favor the original racial combination as long as the over-all genetic structure and the habitats remain the same, although a certain amount of introgression may take place. Over long periods genes may gradually migrate across long distances from the original point of contact and may finally appear in combination where they have selective value."

Chapter IV, *Systems of Genes Controlling Characters and their Significance in Environmental Adaptation and Evolution,* is the longest chapter comprising over one third of the text material. It differs markedly from the previous three chapters in that it does not present new data but rather reviews a considerable segment of the genetic literature dealing with gene systems. The relevance of these reviews to the previous chapters lies in the fact that the gene systems discussed are of the same general sort as the gene system for *P. glandulosa*. Chapter V, *Concepts of the Genetic Structure of Ecological Races,* develops a general concept of the genetic structure and evolutionary importance of ecological races.

In the tradition of the previous volumes a vast amount of the original data are presented in a tabular form and the same precise, clear writing and excellent illustration are evident.

The strength of this book clearly lies in the work on *P. glandulosa*. Hybridization studies and the observation of the responses of cloned individuals to different natural environments are two of the powerful tools of evolutionists. In combining both of these approaches in the study of *P. glandulosa* the authors present a new dimension of information about natural populations. At this moment we cannot predict the amount of influence this publication will have on our understanding of evolution. We can be sure, however, that it will remain the classic work of its kind for many years because the time, facilities, and skills necessary for this type of study are available to few botanists.—HENRY J. THOMPSON, Department of Botany, University of California, Los Angeles.

INDEX TO VOLUME XV

Classified entries: Chromosome numbers, Reviews. New scientific names are in boldface type. Un-annotated taxa in floral lists are omitted from Index.

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